TEACHING AND LEARNING PRACTICES: THEIR EFFECTS ON MATHEMATICS ACHIEVEMENT

By

Dr. HALIMAH AWANG
University of Malaya, Kuala Lumpur, Malaysia.

NOOR AZINA ISMAIL
University of Malaya, Kuala Lumpur, Malaysia.

ABSTRACT

This paper examines the effects of teaching and learning strategies on mathematics achievement among eighth grade students in Malaysia using data from the Third International Mathematics and Science Study (TIMSS) 1999. Factor analysis is used to separate the twenty-five teaching and learning practices into three main factors namely, instructional practices, interactive activities and use of technology. The result of the regression analysis suggests that these factors have significant influence on students' achievement in Mathematics.

INTRODUCTION

Numerous studies have been conducted on in- and out-of-school variables to examine the relationship between their effects on students' performance in mathematics as well as ways to improve their achievement. Instructional strategies, students' background and attitudes towards learning, school and home educational resources have been shown to impact students' learning and understanding of the subject matter directly or indirectly (Grouws and Cebulla, 2000; Wilkins and Ma, 2002; Kiamanesh, 2004). Grouws and Cebulla (2000) documented brief descriptions of instructional strategies and teaching practices to improve mathematics teaching and learning based on several research findings. For example, the term 'opportunity to learn' which includes the scope of the mathematics covered, how mathematics is taught, and the match between students' entry skills and new material is strongly linked to students performance in mathematics. Given the importance of mathematics and quantitative competencies in schools, institutions of higher learning and later life, it is the interest of this paper to examine some of the factors affecting mathematics achievement among Malaysian students.

This paper analyzes data from the Third International Mathematics and Science Study (TIMSS) conducted in 1999 by the International Association for the Evaluation of Educational Achievement (IEA), based in Amsterdam. Specifically this study attempts to examine the influence of teaching practices on mathematics achievement among 8th grade students (Secondary Year 2) in Malaysia. TIMSS which was carried out in 38 participating countries including Malaysia administered mathematics test containing 162 items, representing five content areas of mathematics topics and skills namely, fractions and number sense; data representation, analysis, and probability; geometry; and algebra. Mathematics achievement is then measured by taking the mean of five plausible values obtained in this test. For simplicity, it will be referred to as mathematics scores in this paper.

Data Analysis

In TIMSS, all items of interest in the section of teaching practice use four categories of response scale namely,

'Almost always', 'Pretty often', 'Once in a while', and 'Never'. Teaching practice in this paper takes into account 25 instructional activities as listed in Table 1 together with the proportion of responses in the 'Almost always' category. The p-value indicates the significance level of the multiple comparison tests between the 'Almost always' with the other three categories. The highest proportion of teaching practice is the use of the board by teachers (81%), followed by the practice of giving homework by the teachers (73%), teachers show how to do mathematics problem in class (65%), teachers explain rules and definitions of new topic (56%), and teachers check homework (53%). On the other hand, the data shows that instructional technology and aid such as computers, calculators and projectors is hardly used. The data also indicates that only nine percent of teachers discuss a new topic using a practical problem on a regular basis, twelve percent administer a test and small group discussion, and fifteen percent practice of allowing students to check on each other's homework. The multiple comparison tests between the 'almost always', 'pretty often', 'once in a while', and 'never' responses show that all but two items are statistically significant. The two insignificant tests refer to items where teacher checks homework and discusses completed homework. In sum, schools in Malaysia are still using the same conventional methods of teaching mathematics today as in the past.

Table 1
Teaching Practices

Instructional Activities	Almost always	p-value
Teacher shows how to do math problem	65.3	0.000
Copy notes from the board	40.0	0.000
Have a quiz or test	12.3	0.000
Work on projects	30.4	0.000
Teacher gives homework	73.3	0.000
Begin homework in class	30.6	0.000
Teacher checks homework	52.8	0.281
Check each other's homework	15.4	0.000
Discuss completed homework	23.5	0.102
Teacher uses the board	81.3	0.000
Students use the board	28.9	0.000
New topic - The teacher explains rules and definitions	55.9	0.000
New topic - Discuss a practical problem	9.2	0.000
New topic - The teacher asks what you know	24.3	0.000
New topic - Look at textbook while teacher talks about it	42.1	0.012
New topic - Try to solve a related example	48.5	0.000
Work from worksheets on our own	3.1	0.000
Use things from life to solve problems	5.5	0.000
Work together in pairs or small groups	12.0	0.000
New topic - Work together in small groups on a problem	9.6	0.000
Use calculators	1.2	0.000
Use computers	0.3	0.002
Teacher uses an overhead projector	2.7	0.000
Students use the overhead projector	0.9	0.000
The teacher use a computer to demonstrate ideas	0.3	0.000

Factor analysis was performed on the twenty five teaching practices to find out if they can be grouped into fewer categories for purposes of further analysis. This led to the extraction of three main factors namely, instructional strategies, interactive activities, and technology use. The grouping of factors and their respective items are shown in Table 2.

Table 2
Factor Analysis on Teaching Practices

Factors	Teaching Practices	F1	F2	F3
Instructional strategies	Teacher show how to do problems	0.383		
	Copy notes from the board	0.173		
	Have a quiz or test	0.285		
	Teacher gives homework	0.530		
	Begin homework in class	0.338		
	Teacher checks homework	0.418		
	Check each other's homework	0.323		
	Discuss completed homework	0.403		
	Teacher uses board	0.384		
	Students use board	0.269		
	New topic - Teacher explains rules	0.443		
	New topic - Discuss practical problem	0.252		
	New topic - Ask what students know	0.374		
	New topic - Look at textbook	0.330		
	New topic - Solve related example	0.510		
Interactive activities	Work from worksheet on our own		0.378	
	Solve with everyday life things		0.194	
	Work in pairs or small groups		0.703	
	Work on projects		0.505	
	New topic - Work in small groups		0.811	
Use of Technology	Use calculators			0.165
	Use computers			0.249
	Teacher uses overhead			0.773
	Students uses overhead			0.766
	Teacher uses computer			0.266
	% variance	9.06	6.89	6.25
	Total variance explained		22.20	

Instructional strategies in Factor 1 suggest that they could be separated further into four categories: use of the board (copy notes from board, teacher uses board, students uses board), demonstration by teacher (teacher show how to do problems, teacher explains rules of new topic, solve related example of new topic), teaching instructions (teacher gives homework, teacher checks homework, ask what students know, discuss practical problem, look at textbook when introducing new topic, discuss completed homework) and activities by student (Quiz or test, begin homework in class, check each other's homework).

Factor 1 accounts for 9.06 percent of the variable variance, followed by Factor 2 (6.89 percent) and Factor 3 (6.25 percent) giving a total of 22.2 percent of the variable variance. Having identified the three factors, the mean scores for each factor were calculated and were then correlated with their mathematics achievement. The results are shown in Table 3.

Table 3
Correlations of factors with mathematics scores

	Pearson correlation	Sig. (2-tailed)
Mathematics score	1	
Factor 1. Instructional strategies	0.181	0.000
Factor 2. Interactive activities	-0.230	0.000
Factor 3. Use of Technology	-0.063	0.000

All three factors are significantly correlated with mathematics achievement. Factor 1 which consists of instructional strategies is positively correlated, while Factor 2 (interactive activities) and Factor 3 (use of technology) are negatively correlated with student's

mathematics achievement. The correlation of technology and mathematics achievement is very small in magnitude although it is statistically significant. To explore further, regression analysis is performed on mathematics achievement using the mean scores of the three factors as predictor variables. The result of the regression analysis is shown in Table 4 indicating that these factors have significant influence on mathematics achievement. The adjusted R-squared value of 0.097 suggests that the three factors account for about 10 percent of the variation in the students' mathematics achievement. The small contribution by the regression factors is somewhat expected given that there are only three predictor variables used in the analysis out of the original 25 items listed in Table 1. The positive impact of instructional strategies simply means that the more frequent those instructional practices listed under Factor 1 are carried out, the better the mathematics scores achieved. Similarly, the negative influence of the interactive activities and use of technology mean that the more they are being practiced, the lower the students' achievement marks in mathematics will be. Although Factor 3 is statistically significant, its contribution is very small.

Adjusted R-squared = 0.097

Table 4
Regression Analysis of Mathematics Achievement

Variable	Coefficient	t-statistic	p-value	Collinearity Statistics	
				Tolerance	VIF
Constant	523.922	517.368	0.000		
Teaching and learning strategies	18.439	15.359	0.000	0.991	1.009
Interactive activities	-21.641	-18.561	0.000	0.988	1.012
Use of Technology	-4.329	-3.732	0.000	0.997	1.003

Discussion

Achievement in mathematics is affected by many factors and reasons in and out of the classrooms including methods of learning the subject itself, class size, student home and social life and a variety of socio-economic and demographic characteristics. But it is what goes on in the classrooms that will have the most direct and immediate impact on what and how students engage in learning and their ability to apply what they have learned. It is for this reason that the quality of teaching must be front and centre in efforts to improve students' learning. In this efforts various models of teaching mathematics have been offered focusing on use of technology, student centred learning, peer learning and problem based approach (Deepak, 2005; Hiebert, Morris and Glass, 2003; Dunham and Dick, 1994; Savoie and Hughes, 1994)

In this study the analysis takes into account twenty-five items that were measured to represent teaching and learning practices and condense them into three main factors namely instructional strategies, interactive activities and use of technology. The positive relationship between instructional strategies and mathematics achievement seems to suggest that teachers have to work a lot harder if students are to improve in their mathematics achievement. The issue lies then with the teachers as to whether the teaching itself during the contact hours or the preparation before that would make a difference. The negative influence of interactive activities and use of technology on mathematics achievement are somewhat surprising. However, we should bear in mind that in terms of practice, these two factors account for very small proportion of classrooms in Malaysia. At best even if calculators are used, it would not be beyond arithmetic calculations. Interactive activities where students are encouraged to work in groups and take responsibility for their own learning is still in its infant

stage and it will take sometime before this mind set can be changed.

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ABOUT THE AUTHORS

Dr. Halimah Awang is an Associate Professor at the Department of Administrative Studies and Politics, Faculty of Economic and Institution, University of Malaya. Apart from a general interest in research methodology and data analysis, her research interests include literacy education, achievement of students in schools, and ICT integration in education.

Noor Azina Ismail is Associate Professor at the Department of Applied Statistics, Faculty of Economics and Administration, University of Malaya. Her research interests lie in the field of mathematics education, health and applied statistics.

Noor Azina Ismail